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Interconnections among 2-way social support, ambivalent ageism, productive ageing, and productive engagement in community-dwelling older adults: a network analysis

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Abstract

Background

Social support and age-related attitudes may be closely related to productive ageing and productive engagement among older adults. However, previous studies have mainly focused on individual factors or pairwise associations, leaving the overall pattern of interconnections among the specific components of 2-way social support, ambivalent ageism, productive ageing, and productive engagement insufficiently understood.

Objective

To examine the interconnections among 2-way social support, ambivalent ageism, productive ageing, and productive engagement in community-dwelling older adults.

Methods

A cross-sectional study was conducted among 549 older adults recruited by convenience sampling from five communities in Changsha, China. Participants completed the Brief 2-Way Social Support Scale, Ambivalent Ageism Scale, Productive Activities Questionnaire, and Productive Engagement Scale. Thirteen components of the four constructs were included as network nodes. A network based on Spearman correlations was estimated using the EBICglasso method, and node strength, bridge strength, predictability, and network stability were examined.

Results

Paid work showed the highest node strength. Productive engagement showed the highest bridge strength, although this finding should be interpreted in light of its single-node community structure. Among nodes belonging to multi-node communities, giving emotional support and paid work showed relatively high bridge strength. The strongest edge was observed between cognitive assistance/physical protection and unwanted help, followed by the connection between productive engagement and giving instrumental support. The network showed good stability.

Conclusion

2-way social support, ambivalent ageism, productive ageing, and productive engagement formed an interconnected network. Paid work and the “giving” components of social support showed relatively prominent network connections, providing a more detailed structural perspective on productive life in later adulthood.

1. Introduction

With the rapid growth of the global older population, promoting healthy ageing has become an important public health goal [1]. The World Health Organization defines healthy ageing as the process of developing and maintaining the functional ability that enables well-being in older age [2]. Functional ability is shaped by an individual's intrinsic capacity, the environment, and the interactions between them, and includes the ability to build and maintain relationships and to contribute to society [2]. Within this context, productive ageing has received increasing attention. Productive ageing refers to older adults' participation, according to their willingness and abilities, in activities that contribute to individual and social development, such as family care, volunteering, and paid work [3]. These productive activities reflect the specific forms of participation undertaken by older adults in later life. Beyond activity participation itself, how older adults engage in these roles is also important. Productive engagement further reflects the level and quality of older adults' involvement in productive roles and may range from lower to higher levels of engagement [4]. Considering both activity participation and role engagement may therefore provide a more comprehensive understanding of older adults' social participation in later life. Meanwhile, these productive roles are embedded within broader social contexts and are interconnected with older adults' social capital, family resources, and wider social environments [5].

Within these relational resources, social support is an important component of older adults' social connections. Compared with traditional perspectives that focus primarily on receiving support, 2-way social support considers both the receiving and giving of social support and further distinguishes between emotional and instrumental support [6]. Previous studies have shown that different directions and types of social support are differentially associated with older adults' well-being, health-related quality of life, and social participation [7–9]. Giving social support reflects older adults' active role as providers within social relationships, whereas receiving social support reflects the emotional and instrumental resources available to them [6, 8]. This two-way exchange of support may also be related to older adults' participation in productive activities and their engagement in related roles [7, 10]. Therefore, examining social support from a two-way perspective may help clarify the interconnections between social relational resources, productive ageing, and productive engagement.

Age-related attitudes within older adults' social environments may also be associated with their social participation and productive ageing. Ambivalent ageism conceptualizes prejudice toward older adults as comprising both hostile and benevolent forms. Hostile ageism is expressed through more overtly negative attitudes, whereas benevolent ageism includes cognitive assistance/physical protection and unwanted help, and often appears in seemingly positive forms of helping or protection, making it more difficult to recognize [11, 12]. More recently, ageism has been explicitly incorporated into discussions of productive ageing. Previous work suggests that ageism may permeate productive roles such as work, volunteering, education, and caregiving, and may be related to older adults' activity engagement and associated outcomes [13]. In addition, research among community-dwelling older adults has found an association between experiences of ageism and social participation [14]. Therefore, examining

ambivalent ageism together with 2-way social support may help clarify how social resources and age-related attitudes are interconnected with productive ageing and productive engagement.

The system dynamics framework of productive engagement provides a theoretical basis for understanding these interrelationships [15]. The framework proposes that productive engagement in later life is embedded within a dynamic system involving human capital, social capital, family resources, organizational and policy contexts, and societal attitudes and expectations, with potential interactions and feedback among these components. Within this framework, 2-way social support can be viewed as one form of relational resources, whereas ambivalent ageism reflects age-related attitudes within the social environment. Productive ageing and productive engagement focus, respectively, on older adults' participation in productive activities and their level of engagement in those activities. However, several important gaps remain. First, previous studies have generally examined social support, ageism, productive ageing, and productive engagement as relatively separate constructs or through pairwise associations, leaving the structural positions of their specific components within an interconnected system insufficiently understood. Second, older adults may act as both recipients and providers of social support, yet it remains unclear whether different types of "giving" and "receiving" support show distinct connectivity patterns within networks related to productive life. Third, although ambivalent ageism includes both benevolent and hostile forms, little is known about how its specific components are connected with different productive activities and productive engagement when social support and other productive-life-related factors are considered simultaneously. Conventional correlation and regression analyses are useful for examining associations between variables, but they do not directly characterize how multiple components are interconnected within an overall structure [16]. Therefore, an analytical approach capable of examining multivariable interrelationships within an integrated system is needed.

Network analysis provides an appropriate approach for examining such complex patterns of interconnection. In Gaussian graphical models, variables or dimensions are represented as nodes, whereas edges represent conditional associations between pairs of nodes after accounting for all other nodes in the network [16]. Centrality indices can be used to identify components that are strongly connected to other nodes in the network [16], whereas bridge indices identify nodes that connect different predefined communities [17]. Node predictability further indicates the extent to which a node can be explained by its neighboring nodes [18]. Compared with analyses based only on total scale scores or pairwise correlations, network analysis can therefore provide more detailed information about the structural interconnections among individual components. Therefore, this study aimed to use network analysis to examine the interconnections among 2-way social support, ambivalent ageism, productive ageing, and productive engagement in community-dwelling older adults in China. Specifically, we aimed to: (1) characterize the overall network structure and identify nodes with relatively high overall connectivity; (2) identify nodes connecting different conceptual communities; (3) examine the predictability of individual nodes; and (4) assess the accuracy and stability of the estimated network.

2. Methods

2.1 Study design and participants

This cross-sectional study was conducted among community-dwelling older adults in five communities in Changsha, Hunan Province, China, from July to December 2025. Participants were recruited using convenience sampling. Data were collected at community health service centers by trained researchers who were responsible for questionnaire distribution, survey guidance, and data collection.

The inclusion criteria were as follows: (1) aged ≥ 60 years; (2) able to understand the study procedures and complete the questionnaire; and (3) willing to participate voluntarily. Participants were excluded if they had severe cognitive impairment or were unable to communicate effectively.

The minimum required sample size was calculated using the commonly used formula for cross-sectional studies [19, 20]:

$$n = Z^2_{1-\alpha\ /2} p\left(1-p\right)/\delta^{\ 2}$$

A 95% confidence level was assumed, with $Z_{1-\alpha/2}$ = 1.96. In the absence of prior estimates of the relevant proportion, *p* = 0.5 was used, with a margin of error (δ) of 0.05. The calculated minimum sample size was 385 participants. Considering a potential 20% rate of invalid responses or data loss, the target sample size was increased to 482 participants.

A total of 570 questionnaires were collected. After data quality control, 21 questionnaires were not included in the final analysis, including eight with patterned responses, seven with logical inconsistencies, and six with incomplete responses. Finally, 549 participants were included in the statistical analysis. The reporting of this cross-sectional study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

2.2 Measures

2.2.1 General information questionnaire

A general information questionnaire was developed by the research team based on a review of relevant literature and the objectives of this study. The questionnaire was used to collect participants' demographic and health-related characteristics. The collected information included gender, age, residence, educational level, former occupation, marital status, number of children, living arrangement, personal monthly income, self-rated health, number of chronic conditions, and activities of daily living. An English-language version of the questionnaire is provided in Supplementary file 1.

2.2.2 2-Way Social Support

2-Way Social Support was assessed using the Chinese version of the Brief 2-Way Social Support Scale, originally developed and validated by Obst [9], and subsequently culturally adapted for community-dwelling older adults in China by Cui [21]. The scale consists of 12 items across four dimensions:

receiving emotional support, giving emotional support, receiving instrumental support, and giving instrumental support. Each item is rated on a 5-point Likert scale ranging from 1 (“completely inconsistent”) to 5 (“completely consistent”), yielding a total score of 12–60, with higher scores indicating higher levels of 2-way social support. The Chinese validation study demonstrated good reliability and validity. In the present study, the Cronbach’s α coefficient was 0.924.

2.2.3 Ambivalent Ageism

Ambivalent ageism was assessed using the Chinese version of the Ambivalent Ageism Scale, originally developed by Cary [12], and subsequently adapted and validated among community-dwelling older adults in China by Ding [22]. The Chinese version consists of 12 items across three dimensions: cognitive assistance/physical protection, unwanted help, and hostile ageism. The first two dimensions reflect benevolent ageism, whereas the third reflects hostile ageism. Each item is rated on a 7-point Likert scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”), with higher scores indicating higher levels of ambivalent ageism. The Chinese validation study demonstrated good reliability and validity, with a Cronbach’s α coefficient of 0.902 for the total scale. In the present study, the Cronbach’s α coefficient was 0.829.

2.2.4 Productive Ageing

Productive ageing was assessed using the Productive Activities Questionnaire developed by Xu [23]. The questionnaire assesses older adults’ participation in different types of productive ageing activities. It consists of 10 items across five domains: family care, paid work, volunteering, lifelong learning, and physical activity. Specifically, family care and physical activity each contain two items, paid work and volunteering each contain one item, and lifelong learning contains four items. Each item is rated on a 4-point scale according to the frequency of participation, with higher scores indicating greater participation in productive activities. The original study reported good content validity, with a scale-level content validity index of 0.90 and item-level content validity indices ranging from 0.87 to 1.00, and a Cronbach’s α coefficient of 0.864. In the present study, the Cronbach’s α coefficient was 0.834.

2.2.5 Productive Engagement

Productive engagement was assessed using the Chinese version of the Productive Engagement Scale, originally developed by Matz-Costa [24], and subsequently translated and culturally adapted for community-dwelling older adults in China by Dai [25]. The scale is unidimensional and consists of nine items assessing older adults’ engagement in productive activities. Each item is rated on a 7-point Likert scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”), yielding a total score of 9–63, with higher scores indicating higher levels of productive engagement. The Chinese validation study demonstrated good reliability and validity, with a Cronbach’s α coefficient of 0.923. In the present study, the Cronbach’s α coefficient was 0.923.

2.3 Ethical considerations

This study was approved by the Science and Technology Ethics Review Committee of Changsha Medical University (Approval No. X2025035). All procedures were conducted in accordance with the Declaration of Helsinki and relevant ethical guidelines. Before data collection, participants were informed of the study purpose, procedures, and their right to decline or withdraw from participation at any time without any consequences. Written informed consent was obtained from all participants prior to participation. Participation was voluntary. The collected data did not contain directly identifiable personal information, such as participants' names or identification numbers. All study data were securely stored and were accessible only to the research team.

2.4 Statistical analysis

Statistical analyses were conducted using R (version 4.5.2). Categorical variables were summarized as frequencies and percentages. Continuous variables were described using means and standard deviations or medians and interquartile ranges, as appropriate. Potential common method bias was examined across all 43 items using Harman's single-factor test and by comparing a single-factor confirmatory factor analysis (CFA) model with a correlated four-factor model representing the four measures [26].

The 13 components of 2-way social support, ambivalent ageism, productive ageing, and productive engagement were used as network nodes. To examine the interconnections among the specific components of these constructs, predefined dimension scores were used as nodes for the multidimensional measures, whereas the mean score of the unidimensional Productive Engagement Scale was represented as a single node. This approach preserved the theoretical structure of the constructs and facilitated comparison of network connections among their components. Because several network variables were non-normally distributed, a Gaussian graphical model based on Spearman correlations was estimated using the qgraph and bootnet packages. The EBICglasso method with LASSO regularization was applied to estimate the partial correlation network, with the EBIC tuning parameter set at 0.5 [16]. Nodes represented the 13 components, and edges represented regularized partial associations between nodes after controlling for all other nodes. For visual clarity, only edges with absolute weights ≥ 0.05 were displayed; this threshold did not affect network estimation or network metrics. Node predictability was calculated using the mgm package and expressed as R^2[18].

The 13 nodes were assigned to four predefined communities: 2-way social support, ambivalent ageism, productive ageing, and productive engagement. Node strength and bridge strength were used to evaluate overall node connectivity and cross-community connectivity, respectively [17]. Network accuracy and stability were assessed using 2500 nonparametric bootstrap samples and 2500 case-dropping bootstrap samples. Stability was evaluated using the correlation stability (CS) coefficient, with values > 0.25 considered acceptable and > 0.50 considered good [16].

3. Results

3.1 General characteristics

Table 1 presents the general characteristics of the 549 community-dwelling older adults. Of the participants, 52.6% were female, 52.3% were aged 70–79 years, and 89.3% lived in urban areas. Most were married (75.0%), 59.6% lived with their spouse, and 69.8% had a personal monthly income of 2,000–3,999 CNY. Most participants rated their health as good/generally independent (86.0%), and 61.7% were basically independent in activities of daily living. Detailed characteristics are shown in Table 1.

Table 1
Characteristics of the older adults (N = 549).

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	260	47.4
Female	289	52.6
Age (years)		
60–69	200	36.4
70–79	287	52.3
≥ 80	62	11.3
Residence		
Rural	59	10.7
Urban	490	89.3
Education		
Primary school or below	98	17.9
Junior middle school	239	43.5
Senior high school	153	27.9
College or above	59	10.7
Former occupation		
Unemployed	6	1.1
Farming	66	12.0
Self-employed	86	15.7
Enterprise employee	87	15.8
Civil servant	39	7.1
Public institution employee	265	48.3
Marital status		
Married	412	75.0
Widowed	134	24.4
Remarried	3	0.5

Characteristics	Frequency (n)	Percentage (%)
Gender		
Number of children		
1	119	21.7
2	329	59.9
≥ 3	101	18.4
Living arrangement		
Living alone	47	8.6
With spouse	327	59.6
With spouse and children	86	15.7
With children	89	16.2
Personal monthly income (CNY)		
< 2000	75	13.7
2000–3999	383	69.8
≥ 4000	91	16.6
Self-rated health		
Poor/fully dependent	3	0.5
Fair/partly dependent	33	6.0
Good/generally independent	472	86.0
Very good/able to care for others	41	7.5
Number of chronic conditions		
0	214	39.0
1–2	216	39.3
≥ 3	51	9.3
Unknown	68	12.4
Activities of daily living		
Needs assistance	3	0.5
Basically independent	339	61.7
Fully independent	207	37.7

3.2 Scores for 2-Way Social Support, Ambivalent Ageism, Productive Ageing, and Productive Engagement

The total scores of all four measures showed varying degrees of skewness and were therefore summarized using medians and quartiles. Descriptive statistics for 2-way social support, ambivalent ageism, productive ageing, productive engagement, and their respective components are presented in Table 2.

Table 2
Descriptive statistics for the scales and network dimensions (N = 549).

Scale or dimension	Median (Q1, Q3)
2-way Social support	58.00 (56.00, 59.00)
SS1: Receiving emotional support	4.67 (4.67, 5.00)
SS2: Giving emotional support	4.67 (4.67, 5.00)
SS3: Receiving instrumental support	5.00 (4.67, 5.00)
SS4: Giving instrumental support	4.67 (4.67, 5.00)
Ambivalent ageism	75.00 (71.00, 78.00)
AA1: Cognitive assistance/physical protection	6.50 (6.00, 7.00)
AA2: Unwanted help	6.67 (6.33, 6.83)
AA3: Hostile ageism	5.50 (4.75, 6.00)
Productive ageing	36.00 (34.00, 38.00)
PA1: Family care	4.00 (3.50, 4.00)
PA2: Paid work	4.00 (3.00, 4.00)
PA3: Volunteering	3.00 (2.00, 4.00)
PA4: Lifelong learning	3.50 (3.25, 3.75)
PA5: Physical activity	4.00 (3.50, 4.00)
PE:Productive engagement	31.00 (24.00, 44.00)
Note. Q1 = first quartile; Q3 = third quartile.	

3.3 Common method bias

Potential common method bias was examined using Harman's single-factor test and single-factor confirmatory factor analysis (CFA) [26]. The first factor in the unrotated exploratory factor analysis accounted for 29.44% of the total variance. The single-factor CFA model showed poor fit (CFI = 0.818,

TLI = 0.808, RMSEA = 0.091, SRMR = 0.127). In comparison, the correlated four-factor model comprising 2-way social support, ambivalent ageism, productive ageing, and productive engagement showed substantially better fit (CFI = 0.970, TLI = 0.969, RMSEA = 0.037, SRMR = 0.066). Taken together, these findings did not suggest that a single common factor dominated the observed covariance structure.

3.4 Network structure

3.4.1 Characteristics and interrelationships of the network

Figure 1 presents the 13-node network of 2-way social support, ambivalent ageism, productive ageing, and productive engagement. A total of 61 non-zero edges were identified, representing 78.21% of all possible edges (61/78). After regularization, non-zero edges were retained for most possible node pairs, indicating that conditional associations were broadly distributed across the network. However, edge weights varied considerably, suggesting that the relatively high network density should not be interpreted as uniformly strong connectivity among all nodes. Edge weights for the displayed associations are labelled in Fig. 1. The strongest edge was cognitive assistance/physical protection–unwanted help, followed by productive engagement–giving instrumental support and family care–physical activity.

3.4.2 Node strength, bridge strength, and predictability

Figure 2 and Table 3 present the strength, bridge strength, and predictability of each node. Paid work had the highest node strength (1.09), indicating that it was the most strongly connected node overall in the network. Productive engagement showed the highest bridge strength (0.90), suggesting strong connections with nodes from other communities. However, this high bridge strength may partly reflect its position as a single-node community, because all of its connections were necessarily cross-community connections. Among nodes belonging to multi-node communities, giving emotional support had the highest bridge strength (0.69), followed by paid work (0.63), indicating relatively prominent roles in linking different domains of the network. The mean predictability across the 13 nodes was 30.2%, with physical activity showing the highest predictability (0.38), indicating that approximately 38% of its variance was accounted for by its neighboring nodes in the network.

Table 3
Strength, bridge strength, and predictability of all nodes (N = 549).

Node	Strength	Bridge strength	Predictability (R^2)
2-way Social support			
SS1: Receiving emotional support	0.93	0.49	0.32
SS2: Giving emotional support	0.89	0.69	0.33
SS3: Receiving instrumental support	0.73	0.58	0.18
SS4: Giving instrumental support	0.75	0.52	0.27
Ambivalent ageism			
AA1: Cognitive assistance/physical protection	0.79	0.39	0.30
AA2: Unwanted help	0.85	0.41	0.31
AA3: Hostile ageism	0.75	0.42	0.26
Productive ageing			
PA1: Family care	0.80	0.34	0.29
PA2: Paid work	1.09	0.63	0.38
PA3: Volunteering	0.67	0.26	0.21
PA4: Lifelong learning	1.00	0.61	0.36
PA5: Physical activity	1.00	0.49	0.38
Productive engagement			
PE: Productive engagement	0.90	0.90	0.32

3.5 Network accuracy and stability

Figure 3A presents the results of the nonparametric bootstrap analysis of edge weights in the overall network. The sample estimates were generally close to the bootstrap means, and stronger edges showed relatively narrower confidence intervals, indicating satisfactory estimation accuracy. In contrast, some weaker edges had wider confidence intervals, suggesting greater uncertainty and warranting cautious interpretation.

Figure 3B presents the case-dropping bootstrap results for node strength and bridge strength. The correlation stability (CS) coefficients for both indices were 0.52, exceeding the recommended threshold of 0.50 [16]. This indicates that the centrality estimates remained relatively stable after subsets of cases were removed, supporting good stability of both node strength and bridge strength.

3.6 Bootstrap difference tests within the overall network

3.6.1 Edge-weight difference test

Supplementary Figure S1 presents the bootstrap difference test for edge weights in the overall network. The three strongest edges were observed between cognitive assistance/physical protection and unwanted help, between productive engagement and giving instrumental support, and between family care and physical activity. These edges were significantly stronger than multiple weaker edges in the network.

3.6.2 Node-strength difference test

Supplementary Figure S2 presents the bootstrap difference test for node strength in the overall network. Paid work, which had the highest node strength, showed significantly higher strength than several other nodes. Significant differences were also observed for physical activity and lifelong learning in comparison with several nodes with lower strength.

3.6.3 Bridge-strength difference test

Supplementary Figure S3 presents the bootstrap difference test for bridge strength in the overall network. Productive engagement showed significantly higher bridge strength than several other nodes. Among nodes belonging to multi-node communities, giving emotional support and paid work were also significantly higher than several nodes with lower bridge strength.

4. Discussion

This study used network analysis to examine the interconnections among 2-way social support, ambivalent ageism, productive ageing, and productive engagement in community-dwelling older adults. The results showed a broadly interconnected pattern of conditional associations across these constructs. Paid work showed the highest node strength, while productive engagement showed the highest bridge strength. Among nodes belonging to multi-node communities, giving emotional support and paid work showed relatively high cross-community connectivity. In addition, the strongest edges were observed between cognitive assistance/physical protection and unwanted help, between productive engagement and giving instrumental support, and between family care and physical activity. Overall, these findings reveal an interconnected structure among 2-way social support, ambivalent ageism, productive ageing, and productive engagement, consistent with the systemic perspective that these constructs are interrelated [15].

Paid work showed the highest node strength in the present network, indicating that it had the greatest sum of absolute edge weights connecting it to other nodes.This finding is consistent with recent research on employment in later life. Studies have shown that continued employment after retirement is not merely an economic activity but also involves social participation, personal meaning, and engagement with broader social environments [27]. In the present study, the relatively high network connectivity of paid work may be related to its dual roles as a productive activity and a form of social interaction. Unlike some later-life activities that mainly involve physical maintenance or family

responsibilities, paid work usually occurs in structured work environments. In these settings, older adults contribute through employment, maintain work relationships, and encounter age-related social evaluations [28]. Previous studies have shown that workplaces are important contexts for older workers to receive support from supervisors and colleagues. They are also settings where age-related attitudes and ageism may occur [29]. Therefore, paid work may involve social support exchanges, age-related evaluations, and productive engagement. These characteristics may help explain its broad structural associations with 2-way social support, ambivalent ageism, productive ageing, and productive engagement in the present network.

Productive engagement showed the highest bridge strength in the present network, suggesting broad cross-community connections with other conceptual domains. Because productive engagement constituted a single-node community, all of its connections with other nodes were counted toward bridge strength. This result should therefore be interpreted with consideration of this structural feature [17]. Previous research has also shown that productive engagement among older adults is associated with multiple dimensions of expectations regarding ageing, including physical health, mental health, cognitive function, and functional independence [30]. These findings suggest that productive engagement may be related to a range of individual and age-related cognitive factors. Therefore, the broad cross-community connections observed in the present study are supported to some extent by previous empirical evidence, although the magnitude of bridge strength should not be interpreted independently of the single-node community structure.

Among nodes in multi-node communities, giving emotional support showed the highest bridge strength, followed by paid work. This finding suggests that actively providing emotional support may extend beyond exchanges within 2-way social support and may also be related to broader social and productive aspects of later life. Previous research among Chinese older adults found that giving and receiving support have different correlates, indicating that support provision is not simply the counterpart of support receipt but represents a relatively distinct active role within social relationships [31]. More recent research further showed that providing social support was associated with productive roles such as employment and volunteering and was involved in the associations of these roles with meaning in life [32]. Therefore, the relatively high bridge strength of giving emotional support may reflect its position at the intersection of interpersonal support exchange and broader productive life in later adulthood. Paid work also showed relatively high bridge strength. Together with its highest node strength, this finding suggests that the connectivity of paid work was not only broad across the network but also extended beyond the productive ageing community to other conceptual domains. This further indicates that the prominent network position of paid work was reflected in both its overall connectivity and its cross-community connections.

Beyond the node-level connectivity patterns, several relatively strong pairwise associations were also observed, with the strongest association occurring between cognitive assistance/physical protection and unwanted help. Recent studies suggest that overprotection and unsolicited help, as forms of benevolent ageism, may share underlying assumptions that older adults are less capable, more

dependent, or more vulnerable [33]. Experimental evidence has also shown that unnecessary help toward older adults is associated with lower perceived competence [34]. Therefore, the strong association between cognitive assistance/physical protection and unwanted help observed in this study may reflect a shared protective age-related view: perceiving older adults as needing additional assistance or protection may co-occur with a greater tendency to provide help even when it has not been requested. Productive engagement also showed a relatively strong cross-construct association with giving instrumental support. Together with the prominent bridge position of giving emotional support, this finding further suggests that the “giving” dimension of social support may be closely connected with older adults’ productive lives. Recent research has shown that providing social support is associated with employment and volunteering among older adults and is also related to meaning in life [32]. Therefore, the relatively strong association between productive engagement and giving instrumental support may reflect that older adults, while engaging in productive roles, may also take on active roles in providing practical help and resources to others.

5. Strengths and limitations

This study has several strengths. First, 2-way social support, ambivalent ageism, productive ageing, and productive engagement were examined within a single analytical framework. Network analysis was used to examine conditional associations among their specific components, providing a more detailed structural perspective beyond conventional analyses based on total scores. Second, node strength, bridge strength, and edge patterns were examined simultaneously, and bootstrap procedures were used to assess the accuracy and stability of the estimated network, thereby enhancing the robustness of the network interpretation.

Several limitations should also be acknowledged. First, the cross-sectional design precludes conclusions about the temporal ordering or causal direction of the observed associations. Longitudinal studies are therefore needed to further examine how these relationships may change over time. Second, participants were recruited through convenience sampling from five communities in Changsha, China. The geographic and sociodemographic characteristics of the sample may limit the generalizability of the findings to older adults in other regions or populations. Third, the data were primarily based on self-reported measures and may therefore be subject to recall bias and social desirability bias. Although Harman’s single-factor test and confirmatory factor analysis did not suggest that a single common factor dominated the covariance structure of the observed variables, these statistical procedures cannot completely rule out the influence of common method factors. Future studies could incorporate multiple data sources or objective measures to further validate the present findings. Fourth, productive engagement constituted a single-node community in the present network. Consequently, all of its connections with other nodes contributed to its bridge strength, which may have resulted in a higher bridge strength than that of nodes belonging to multi-node communities. This result should therefore be interpreted with caution. Finally, the network included only prespecified variables related to social support, ageism, and productive life. Other potentially relevant factors, such as health status, economic resources, family context, and community environment, were not included. Future studies should

examine these relationships in more representative samples across different regions, using longitudinal designs and incorporating a broader range of individual and contextual factors.

6. Conclusion

This study provides a network perspective on the interconnections among 2-way social support, ambivalent ageism, productive ageing, and productive engagement in community-dwelling older adults. Paid work showed the highest node strength, while giving emotional support showed relatively high cross-community connectivity among nodes in multi-node communities. The relatively strong association between productive engagement and giving instrumental support further suggests that the “giving” dimension of social support may be closely related to older adults’ productive lives. In addition, the strong association between cognitive assistance/physical protection and unwanted help suggests that different forms of benevolent ageism may share similar age-related assumptions. Overall, these findings provide a more differentiated structural perspective on the links among social relationships, age-related attitudes, and productive life in later adulthood. Longitudinal studies are needed to further examine these associations.

Declarations

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Authors’ contributions

Zemei Xiao: Conceptualization, Methodology , Formal analysis , Validation , Writing – original draft, Funding acquisition, Project administration.

Xueqing Xia: Conceptualization, Investigation, Data curation, Resources.

La Li: Investigation, Data curation, Resources.

Xueqin Zhang: Investigation, Data curation, Resources.

Jun Jiang: Investigation, Data curation, Resources.

Xinyun Ding:Investigation, Data curation, Resources.

Xueqing Gong:Conceptualization, Methodology, Formal analysis, Software, Validation, Writing – review & editing, Project administration.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical Considerations

This study was granted an exemption from ethics review by the Science and Technology Ethics Review Committee of Changsha Medical University (Reference No. X2025035). Participation was voluntary, and data were collected anonymously.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Figures

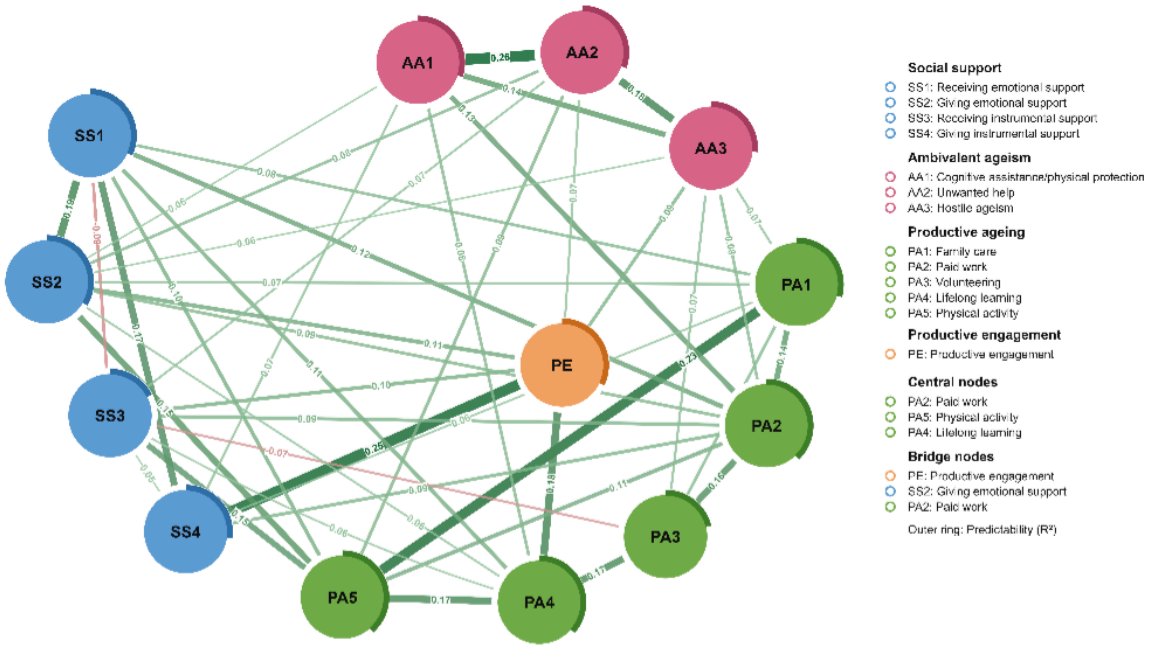


Figure 1

Network structure of social support, ambivalent ageism, productive ageing, and productive engagement.

Nodes represent the 13 study variables; node colours indicate the four communities. Green and red edges indicate positive and negative regularized partial correlations, respectively. Edge thickness reflects the absolute edge weight, and numerical labels show edge weights. Edges with absolute weights below 0.05 are hidden for readability. Outer rings indicate node predictability (R^2).

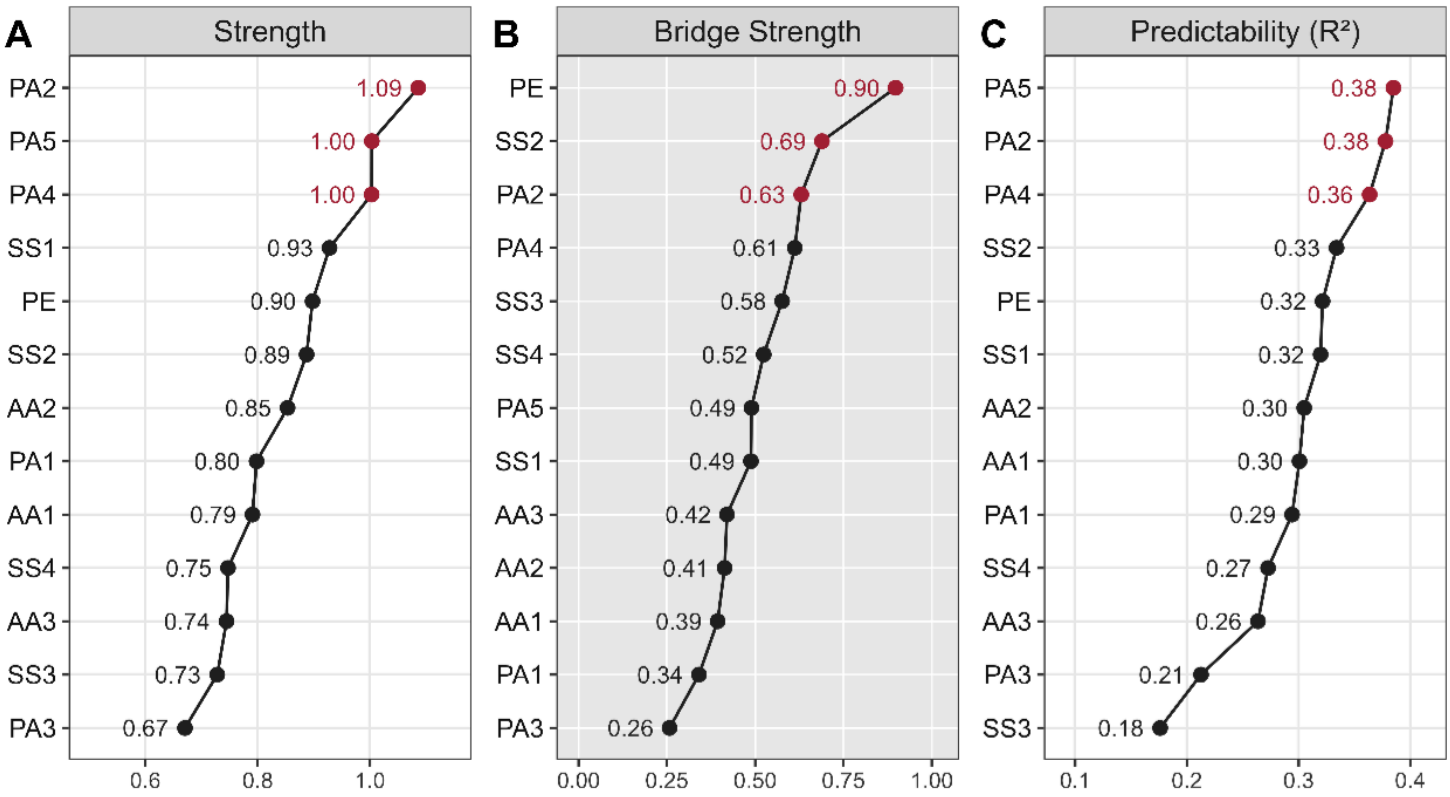


Figure 2

Node strength, bridge strength, and predictability.

A, Node strength; B, bridge strength calculated across the four communities; C, node predictability (R^2).Node abbreviations are defined in Figure 1.

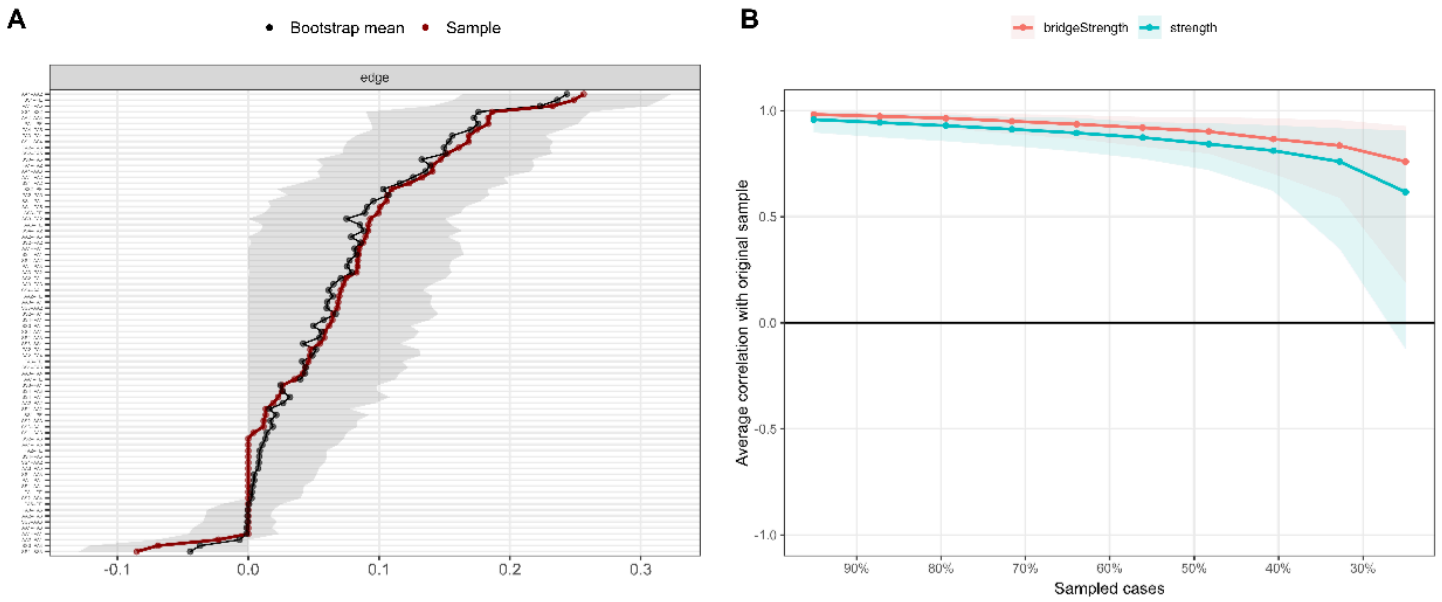


Figure 3

Network accuracy and stability.

A, Nonparametric bootstrap analysis of edge-weight accuracy; B, case-dropping bootstrap analysis of node strength and bridge strength

Supplementary Files

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